



PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Valve Tappets for Internal Combustion Engines

We, EATON MANUFACTURING COMPANY, a Corporation organized under the Laws of the State of Ohio, United States of America, of 739, East 140th Street, Cleveland, State of Ohio, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to hollow cylindrical valve tappets for internal combustion engines which tappets are made of a forgeable metal, the principal object being the provision of a valve tappet of minimum weight and in which the distortion thereof under load is so controlled as to minimize if not eliminate the possibility of seizure of the tappet in its guide.

It has been proposed to provide ribs on the cylindrical portion of conventional tappets which are made of cast iron and have ports or holes of substantial size in the wall of the tappet. The ribs are arranged between these ports or holes to reinforce the otherwise weak material. Tappets of this kind cannot respond to the loads they have to carry in the manner hereinafter described, which forms the basis of the present invention. The tappets to which the present invention applies consist of a forgeable metal and have a thin walled, unbroken cylindrical portion which is subject to flexing under the operating loads.

According to the present invention there is provided a hollow cylindrical valve tappet body for an internal combustion engine including a portion having a wall consisting of a forgeable metal, which wall is unbroken and subject to expansion, without permanent deformation, under the compressive loads to which it is subjected in service, said valve tappet comprising on said portion one or more ribs formed integrally with the inner surface of said wall and projecting radially inwardly therefrom in circum-

ferentially continuous condition intermediate the ends of said walls with the effect that at the point of re-inforcement the wall will be prevented from radial expansion under such compressive loads.

In present day airplane engines valve tappets are necessarily made of a material length and of a material diameter in order to provide sufficient bearing area between themselves and their guides to withstand the movement and forces to which they are subjected to in operation. For this reason they are usually made hollow in order to reduce the weight thereof. The greatest saving in weight in such tappets is obviously capable of being obtained by reducing the wall thickness thereof.

The ribs provided in accordance with the present invention are not required to be of great radial dimensions as compared to the radial dimensions of the tappet. This fact together with the fact that the tappet can have very thin walls results in that such tappets may be very light in weight.

In the accompanying drawing which illustrates a suitable embodiment of the present invention and in which like numerals refer to like parts throughout the several different views:—

Fig. 1 is a partially broken, partially sectioned view taken through an internal combustion engine provided with a valve tappet constructed in accordance with the present invention;

Fig. 2 is an enlarged sectional view taken axially through the body of the tappet shown in the engine of Fig. 1, illustrating in exaggerated form and by dotted lines the relative expansion and contraction of different portions thereof in service;

Fig. 3 is a view of a tappet substantially identical to that shown in Fig. 2 with the exception of the internal rib of the present invention is not present, and illustrating by dotted lines and in exaggerated form or extent the manner in

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which it would radially expand under compressive load in service;

Fig. 4 is a view similar to Fig. 2 but illustrating the tappet in an initial stage of construction and illustrating the manner in which the internal rib is formed therein; and

Fig. 5 is a view similar to Fig. 2 but illustrating a tappet of relatively greater length as compared to its diameter and the use of a plurality of internal ribs to offset the radial expansion thereof under compressive forces met with in service.

The engine shown in Fig. 1 will be seen to include a crankcase 10 having a cylinder block 12 in which is received a cylinder liner 14 in which a piston 16 is reciprocally received in a conventional manner. A conventional crankshaft 18 is rotatably supported in the crankcase 10 by suitable bearings such as 20 and is conventionally connected by a connecting rod 22 with the piston 16 in the cylinder liner 10. The cylinder block 12 is provided with a valve port 24 communicating an intake or an exhaust passage 26 with the space above the piston 16 in the cylinder liner 14, a valve 28 serving to control the opening and closing of the port 24. The valve 28 is guided in its reciprocable movements by a valve guide 30 and spring means indicated generally at 32 cooperate with the valve 28 in a conventional manner to constantly urge it towards closed position. The valve 28 is opened against the force of the spring means 32 by means of a rocker arm 34 pivotally mounted on the cylinder block as at 36. The rocker arm 34 is operated from the crankshaft 18 by means of a cam 38 concentric with the crankshaft 18 and driven therefrom and acting through a valve tappet indicated in Fig. 1 generally at 40 and a push rod 42. The valve tappet 40 is guided in its reciprocating movements in the bore of a tappet guide 44 carried by a member 46 suitably and rigidly fixed to the crankcase 10 and/or cylinder block 12.

The valve tappet 40 shown by way of illustration comprises a main body portion indicated generally at 50, the lower end of which is bifurcated as at 52 and within which is received a roller 54 which rides upon the periphery of the cam 38, the roller 54 being rotatably mounted in the bifurcated lower end of the main body portion by means of a pin 56 preferably pressed fitted in a bore 58 extending transversely through the legs of the bifurcated lower end of the main body portion 50. The major portion of the main body portion 40 is hollow and open at its upper end which is closed by a shouldered plug 60 received therein and the shoulder of

which seats upon the upper end of the main body portion 40. The plug 60 is provided with a partially spherical seat 62 therein in which the lower ball end of the push rod 42 is received. The hollow walls of the main body portion 40 are imperforate except for one or more relatively small holes 64 provided there-through adjacent the lower end of the hollow interior of the main body portion 40 and which hole or holes are adapted to be intermittently aligned during operation with an oil passage 66 leading to the bore of the tappet guide 44 and connected as by means of a tube 68 with the pressure lubricating system of the engine. The oil thus led to the interior of the tappet is discharged upwardly through a central hole in the plug 60 and into the interior of the push rod, from which it is carried to the bearing for the rocker arm 34. The oil in the passage 66 in being fed to the bore of the guide 44 serves to lubricate the wearing surfaces between the guide and the tappet 40.

The main body portion 50 of the valve tappet 40 is illustrated in greater detail in Fig. 2 and it will be understood that it is the character of the walls thereof that constitutes the gist of the present invention. As indicated in Fig. 2 the bore 70 extends from the upper end of the main body portion 50 to a point immediately above the bifurcation 52 in the lower end thereof where such bifurcation is employed, otherwise into a similar relation with the cam contacting face of such end of the main body portion where the tappet is formed for direct engagement with an operating cam and without the inter-position of a roller such as 54. Preferably and as indicated in Fig. 2 the substantially imperforate walls of the hollow portion of the main body portion 52 are thickened as at 72 adjacent the open end of the tappet so as to better prepare it for reception of the plug 60 or the equivalent for transmitting the load therefrom with less liability of deformation or the like of such end. It will be appreciated that the walls of the hollow portion of the tappet body 50 are unusually thin as compared to the wall thicknesses of similar constructions employed in conventional practice. For instance, in a tappet having such thin wall portion approximately $2\frac{5}{8}$ " long and an external diameter of $1\frac{1}{16}$ "ths of an inch the wall thickness may be on the order of $\frac{1}{32}$ " of an inch. This size of tappet conforms in external dimensions to those now conventionally employed in conventional types of large radial engines now being produced in great quantities for aircraft use, but in which tappets a wall thickness

of substantially twice or more than that indicated is conventionally being employed.

In accordance with the present invention an internal rib or bead 74 is formed integrally with the thin walls of the body 50 and preferably but not necessarily midway between the thickened upper end 72 and the closed lower end thereof. Preferably it is midway the length of the thin walled portion where the length of the thin walled portion is such that one such rib will suffice. The rib or bead 74 is circumferentially unbroken the rib is axially elongated and of a length greater than either its radial thickness or the thickness of the wall of the tappet body. In the particular case shown its cross-sectional configuration approximately conforms to part of a segment of a circle and it is approximately fifteen times as long as it is thick, this being by way of illustration of one form and size of rib or bead which has proven successful in tappets of the size stated and subjected to the loads met with in engines of the type referred to. The radial thickness of the rib or bead 74 in the particular example shown is substantially equal to the wall thickness of the thin walled portion of the main body portion 50.

Referring now to Fig. 3 a tappet body is shown in which the various parts thereof are indicated by the same numerals as in Fig. 2 except that such numerals bear a prime mark. The tappet shown in Fig. 3 is identical to that shown in Fig. 2 with the exception that the rib 74 is eliminated, the thin side walls being of uniform thickness from end-to-end. When the tappet shown in Fig. 3 is subjected to the load conventionally met with in an engine of the size and type described, the maximum compressive load causes the side walls to expand as indicated in greatly exaggerated form by the dotted lines 80, such expansion following Poisson's ratio and in amounts up to 0.0007". Inasmuch as these tappets are fitted in their guides in actual practice as close as possible and still permit a running fit, normally requiring a clearance between the tappet and its guide of 0.0005" or less, it will be appreciated that under such conditions the valve tappet body shown in Fig. 3 will expand to such an extent in service as to take up all clearance between it and the guide, eliminating the lubricant to a great extent and in a relatively short time causing a seizure between the tappet and its guide. On the other hand, by the employment of a rib such as the rib 74 in Fig. 2 this expansion under load can be completely or substantially completely eliminated so that even in spite of the

equivalently thin walls and identical loads the valve tappet body illustrated in Fig. 2 will maintain a desired, or at least a workable, degree of clearance between it and the walls of its guide.

Theoretically the deformation of the valve body shown in Fig. 2 will include an expansion of it as indicated in greatly exaggerated form by the dotted lines 82 between the rib 74 and the opposite end portions of the tappet body 50, and a radial contraction, indicated in greatly exaggerated form by the dotted line 84 connecting the dotted lines 82, over the axial length of the rib 74 and portions of the thin walls immediately adjacent thereto. In actual practice, however, no increase in the diameter of the body of the tappet between the ribs 74 and the opposite ends of the tappet has been observed, but the central portion over the axial length of the rib 74 has shown a decrease in diameter of 0.0003" under the same loads as have caused an expansion of 0.0007" with the construction illustrated in Fig. 3.

Obviously, by changing the radial thickness of the rib 74 the amount of contraction of the equivalent axial portion of the tappet body may be varied so that almost any desired condition of deformation under load may be obtained. Ordinarily it will be desirable to make the ribs 74 of such radial thickness as to maintain the major areas of the thin walled portion of the tube against increase in radial dimensions under load and so as to, in effect, maintain such major areas at substantially the same diameter as that determined for the proper clearance for the tappet in its cooperating guide when the tappet body is in free and unstressed condition. This is for the reason that under such circumstances the fit of the tappet body in the guide will be constant under all conditions, that is whether it is under load or not. The small axial length of the tappet body under such conditions which will decrease in external dimensions will not be large enough to materially detract from the desired area of contact between the tappet body and its guide and will, therefore, not materially affect the wear characteristics of the tappet in the guide.

The term "thin walled" has heretofore been employed to designate a characteristic of the valve tappet of the present invention and the only specific example given has been a tappet having such thin walls of certain length and diameter and of approximately $\frac{1}{32}$ nd of an inch in thickness. It will be appreciated, however, that the term "thin walled" is a relative term and what may be thin walled in one construction may not be so

considered in another, depending upon the relative length of the thin walled section as compared to its diameter, the maximum load which the tappet is required to transmit through it, the material from which the tappet is made and its condition of hardness, etc. The term "thin wall" as herein employed is intended to mean a wall of such thickness that under the maximum loads which it is designed to carry in service the thin walled portion of the tappet body would radially expand to such a degree as to take up substantially all or most of the clearance intended to exist between it and the wall of the cooperating guide and thereby endanger sticking of the tappet body in the guide, were it not for the presence of the internal rib or ribs of the present invention.

Although the internal rib or ribs of the present invention may be provided in the bore of the tappet body in any suitable or conventional manner the method of forming them illustrated in Fig. 4 is preferred particularly in view of the fact that the internal surfaces of the main body portions of such tappets should be of a smooth and polished nature, which effect would be difficult to obtain if it were attempted to machine the ribs directly in the bore of the tappet body. According to the method disclosed in Fig. 4 and which illustrates the method of forming the tappet body illustrated in Fig. 2, a blank is first formed of slightly greater length than the desired length of the finished body. This blank is of circular section and generally of an external diameter as illustrated at 86 sufficiently larger than the diameter of the desired finished body to provide sufficient stock for the later machining operations. It is provided with a bore 88 of constant diameter throughout, equal in diameter to the maximum diameter desired in the bore of the finished product, and of a length equivalent to the bore 70 desired in the finished tappet. The bore 88 is preferably brought to a condition of relatively high or fine finish, this being readily possible because of the fact that it is fully cylindrical and is not obstructed by any rib such as the rib 74 or any constriction such as is provided by the thickened upper portion 72 in the final product. The lower end of the blank shown in Fig. 4 may be substantially identical to the size and shape of the lower end of the finished tappet except that it need not be bifurcated nor provided with the cross-hole 58 as will occur in the final product, these features preferably being added later.

In the axial length of the blank in Fig.

4 corresponding with the position of the rib 74 in the final product, the blank is externally provided with a circumferentially extending rib or bead 90 which is of a cross-sectional area substantially equal to the cross-sectional area of the bead 74 in the final product. Its cross-sectional contour may be varied to obtain any desired cross-sectional configuration of the bead 74 in the final product as will be readily appreciated. At its upper end the blank shown in Fig. 4 is provided with an increased wall thickness providing a radially outwardly projecting integral collar portion 92 thereon, the same being of substantially the same or substantially greater cross-sectional area as the thickened end 72 desired in the final product.

The lower solid end of the blank shown in Fig. 4 and above described is inserted into a ring die 94, a plunger such as 96 is inserted into the bore 88 and against the solid bottom wall thereof, and a relative force is exerted between the plunger 96 and the ring die 94 to force the blank through the ring die 94. Inasmuch as the bore 98 in the ring die 94 is substantially the same as the diameter 86 of the blank, in pushing the blank through the ring die the bead or rib 90 is displaced radially inwardly until it is located in the plane of the walls of the body and an equivalent amount of metal is projected radially inwardly of the bore 88 to form the rib 74 in the final product. Likewise that portion of the thickened end 92 of the blank which is located outwardly of the diameter 86 is forced inwardly until its outer diameter is the same as the diameter 86, and the metal on the inner side thereof is displaced radially inwardly into the bore 88 to form the thickened end wall portion 72 of the final product. Inasmuch as the walls of the bore 88 were in smooth and polished condition before the last-mentioned operations, it will be appreciated that the walls of the bore 70, including the inner surfaces of the rib 74 and the thickened end wall portion 72, will be correspondingly smooth and polished in the final product.

After the last-mentioned operation it will usually be desirable to re-machine the internal surface of the thickened end 72 to insure its correct size and concentricity with the axis of the tappet body, the slot 52 and cross-hole 58 will be machined in the bottom, together with the holes 64, the whole then preferably being hardened and the external surfaces ground to final shape and size.

As previously mentioned the relative length of the thin walled portion of the tappet body such as that described as

compared to its diameter is a factor in the amount of radial expansion which will occur upon a given axial compressive load being applied to the tappet body, the greater the relative length as compared to the diameter the greater the amount of radial expansion. In such cases it may be necessary to employ two or more internal ribs such as the ribs 74 heretofore described in order to properly control the thin walls against undue radial expansion. Such construction is illustrated in Fig. 5 which is identical to the construction illustrated in Fig. 2 except for the relative length as compared to the diameter. Inasmuch as this is the only change from the prior construction, equivalent parts therein are indicated by the same numerals as in Fig. 2 except that such numerals bear a double prime mark. In this case it will be noted that two ribs 74'' are employed, these being so positioned with respect to each other and the length of the thin walled portion of the tappet body as to be substantially equally spaced from each other and from the corresponding heavier end portions of the tappet body. In this case the two ribs have the effect of breaking up the length of the thin walled portion of the tappet body 50'' into three relatively short sections, whereas in the previously described construction the rib 74 broke up the corresponding length of the body 50 into two such sections. Any desired number of ribs may, of course, be employed but it is, of course, desirable to use the minimum number capable of accomplishing desired results inasmuch as under such circumstances a tappet body of minimum weight will be provided.

It is to be noted in connection with the present invention that the rib or ribs 74 provided in accordance with the present invention are not considered as conventional reinforcing ribs as are the ends of the prior art mentioned at the beginning of this specification. The function of the ribs according to the invention is to provide a centre of mass located radially inwardly of the centre of mass of the thin side walls *per se* which under the force of compression applied to the tappet will cause that and adjacent areas of the thin walls to minimize and preferably reverse its tendency toward radial outward expansion which would otherwise occur, and even prevent or actually reverse such outward expanding of the thin walls and effect an actual radial contraction thereof if desired. As previously stated, the thin

walls without such rib or ribs are themselves capable of taking the compression loads to which they are subjected in service without permanent deformation but not without temporary deformation, so they do not require such ribs for reinforcing purposes. The ribs are provided for controlling the temporary distortion which occurs under such circumstances.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A hollow cylindrical valve tappet body for an internal combustion engine including a portion having a wall consisting of forgeable metal, which wall is unbroken and subject to expansion, without permanent deformation, under the compressive loads to which it is subjected in service, said valve tappet comprising on said portion one or more ribs formed integrally with the inner surface of said wall and projecting radially inwardly therefrom in circumferentially continuous condition intermediate the ends of said walls with the effect that at the point of re-inforcement the wall will be prevented from radial expansion under compressive forces.

2. A valve tappet body according to claim 1, wherein said unbroken wall portion is bounded at each axial end by more rigid wall portions.

3. A valve tappet body according to claim 1 or 2, in which the length of the said unbroken wall portion is substantially greater than its diameter.

4. A valve tappet body substantially as hereinbefore described with reference to the accompanying drawings.

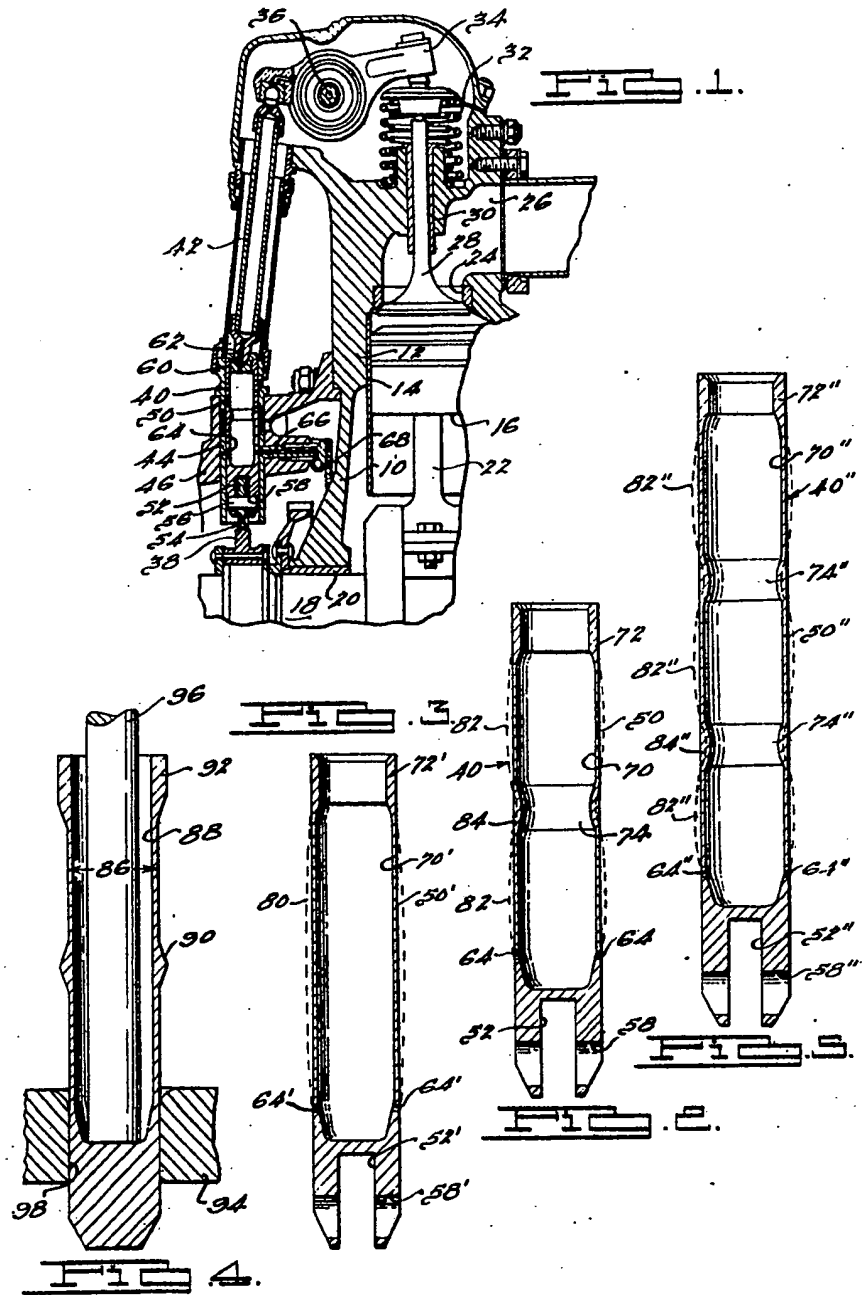
5. An internal combustion engine of the type wherein a spring pressed valve is employed for controlling the opening and closing of a port, a cam is provided for effecting operation of the valve, and means are provided operatively interconnecting said cam and valve, said means comprising in part a tappet guide in combination with a valve tappet body according to any of claims 1 to 4, which is slidably disposed in the bore of said guide.

Dated the 19th day of June, 1945.

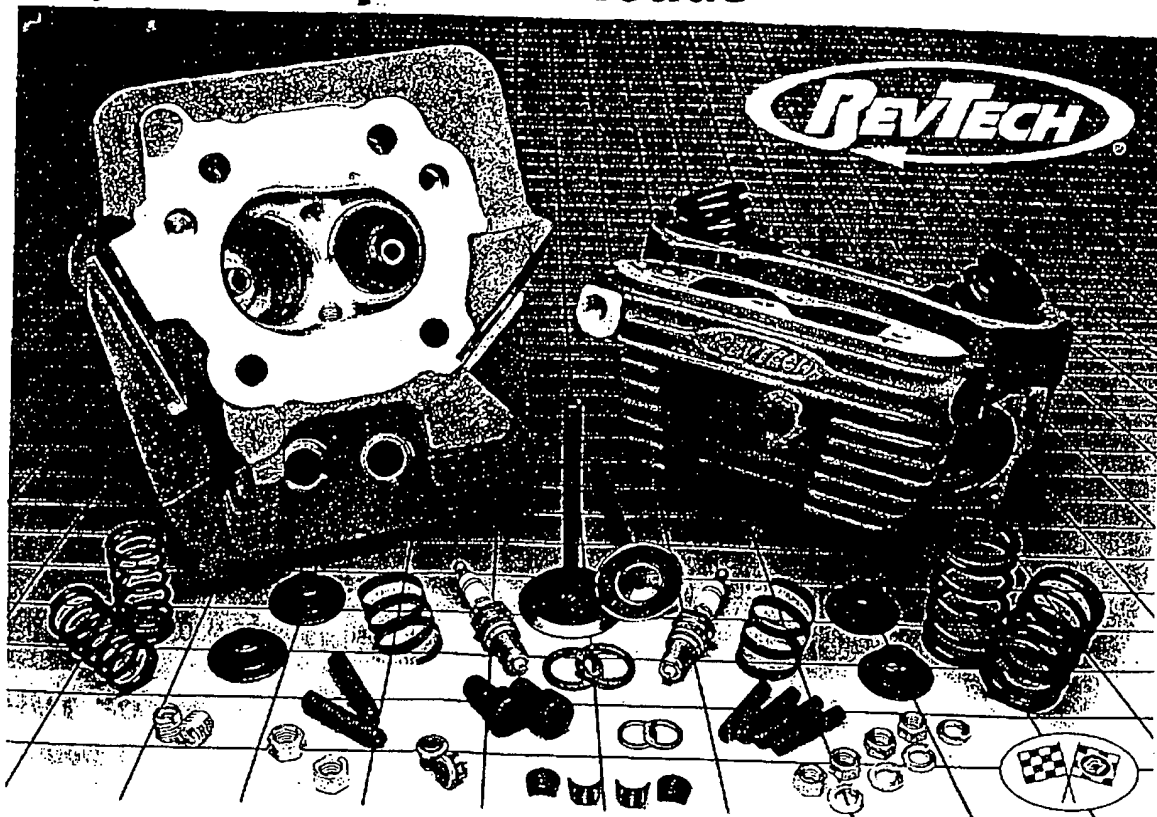
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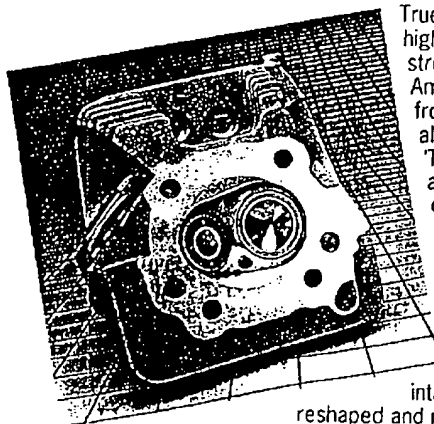
[This Drawing is a reproduction of the Original on a reduced scale.]



RevTech™ Cylinder Heads



8



True 'bolt-on' race-quality high-performance heads for street bikes. Completely American-made and cast from '356' aircraft-quality aluminum heat-treated to 'T6' and then machined and assembled by some of the biggest names in the industry. Unlike other companies manufacturing or modifying cylinder heads, RevTech™ heads are ready-to-install with no 'down-time.' The

intake ports have been reshaped and raised .100" using 'D-shape' technology to increase flow, yet still work with all of the stock intake manifolds. The combustion chambers have been cast and machined into semi-bathtub shapes that are more turbulent and thermally efficient than stock chambers, and are available in stock and high-compression versions to fit Evolution® Big Twin and Sportster® models. The newest additions to the line include two versions for Evolution® Big Twin models with big bore cylinders. The high-compression heads have a compression ratio of approximately 10:1 (stock bore and stroke, and stock pistons with valve-relief pockets). The valves, valve seats and spring components are high-performance automotive-quality parts. The one-piece stainless steel valves have nitrided stems, hardened tips and swirl-polished heads. The 1.940"-diameter intake valves permit the cylinders to fill with air more efficiently creating large increases in torque and horsepower. The tulip-shaped exhaust valves have stock 1.610"-diameter heads and the special heat-treated, high nickel-content valve seats are compatible with all types of fuels. The 3-piece valve springs feature

a flat wound damper spring to eliminate spring surge and will work with cams up to .600" lift. All RevTech™ cylinder heads are set up for dual 12mm spark plugs and come complete with a pair of spark plugs as well as a pair of sockethead plugs for single spark plug applications. A hardware kit containing the exhaust and top motor mount studs is also included. Sold in sets.

Stock Compression Heads

- 59-600 Fit Evolution® Big Twins from 1984 to present
- 59-630 Fit 1200cc Evolution® Sportster® models from 1988 to present

High Compression Heads

- 59-695 Fit Evolution® Big Twins from 1984 to present
- 59-696 Fit 1200cc Evolution® Sportster® models from 1988 to present

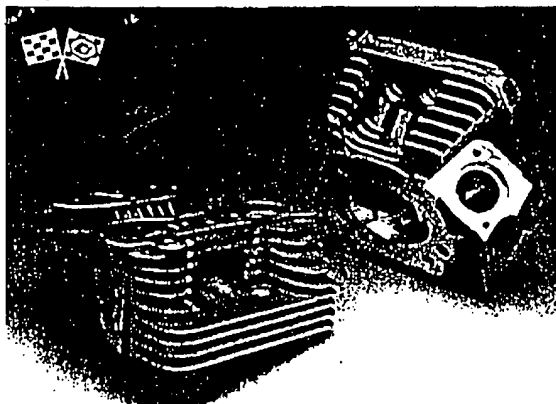
Big Bore Heads for Evolution® Big Twins

- 59-699 Fit big bore cylinders with stock head bolt pattern. Has a wider 77cc combustion chamber to match the larger bore
- 59-690 Fit Axtell 3 1/16" big bore cylinders which use O-ring style head gaskets and have small-diameter headbolt holes

Replacement Parts

- 59-620 1.940" intake valve (+.100") with hard-chrome stem (sold each)
- 58-089 1.940" intake valve (+.100") with nitrided stem (sold each)
- 59-621 1.610" exhaust valve (stock) with hard-chrome stem (sold each)
- 58-093 1.610" exhaust valve (stock) with nitrided stem (sold each)
- 59-638 Stud kit for Evolution® Big Twin heads
- 59-639 Stud kit for Evolution® Sportster® heads
- 59-640 Valve spring kit
- 59-633 Valve spring shim kit
- 59-646 Cast iron intake/exhaust valve guide with unfinished I.D. (sold each)

Cylinder Heads



RevTech™ Cylinder Heads for Evolution® Motors - Without Component Parts

These cylinder heads are made from the same high-quality 'T-356' aluminum castings as our Deluxe street heads, but are offered empty without any of the valve components for the head builder who wants to do his own valve job. The intake ports are raised .100" and are hand-finished along with the exhaust port and bathtub-shaped combustion chamber. Valve seats are installed ready to accept oversized 1.940" intake valves and stock size exhaust valves. These heads are set up for dual 12mm spark plugs and come with motor mount and exhaust studs.

8

59-602 Fits all Evolution® Big Twin models from 1984 to present

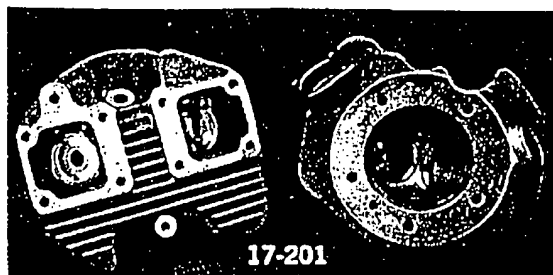
59-603 Fits 1200cc Evolution® Sportster® models from 1988 to present



S.T.D. Cylinder Heads for Evolution® Big Twin Models

Like the S.T.D. heads for Pan/Shovel applications, these high-performance heads are cast from '356' aircraft-quality aluminum which has been heat-treated to 'T6'. The intake ports have been raised 3/8" to facilitate the entrance of the air/fuel mixture into the 'bathtub' shaped combustion chambers, thereby increasing flow and producing more horsepower. Also featured are dual 14mm sparkplug holes and large-diameter valve seats which are compatible with unleaded gas, provide more stability in the heads and will permit the use of larger-than-stock valves. These heads are designed to accept the stock intake manifold or compliance fittings, valve guides, springs and exhaust pipes. **Sold in sets.**

17-119 Cylinder head set for Evolution® Big Twins



S.T.D. Cylinder Heads for Shovelheads

These all-new cylinder heads are cast from the same high-quality '356-T6' aluminum as our other S.T.D. heads and are available in eight different configurations to satisfy even the pickiest of motor builders. You can take your choice of 2- or 4-plugs, rubber band or O-ring manifolds and standard or big bore models. These heads accept 14mm spark plugs and feature chrome-alloy steel valve seats compatible with all types of fuels. The O-ring style heads use the 1948 thru 1979-style valve guides and the rubberband style heads use the 1979 thru 1984 valve guides and seals. **Sold in sets.**

For Standard Bore Cylinders

17-200 2-plug O-ring manifold

17-201 4-plug O-ring manifold

17-204 2-plug rubber band manifold

17-205 4-plug rubber band manifold

For Big Bore 3 5/8" Bore Cylinders

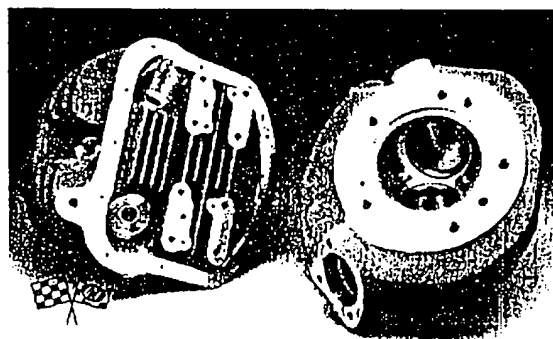
17-202 2-plug O-ring manifold

17-203 4-plug O-ring manifold

17-206 2-plug rubber band manifold

17-207 4-plug rubber band manifold

Note: Because steel head bolt inserts are not used in these heads it will be necessary to source a set of 7/16"-14 head bolts to facilitate installation.



S.T.D. Pan/Shovel Cylinder Heads

These new offerings from S.T.D. are designed to fit on either Panhead or Shovelhead 1200cc barrels. They're cast from '356' aircraft-quality aluminum which has been heat-treated to 'T6' and feature chrome-alloy steel valve seats, dual 14mm sparkplug holes, external oil lines and Shovelhead O-ring style intake manifold ports. They require the use of 1948-79 Big Twin valve guides, Shovelhead valves, exhaust pipes and intake manifold. However, Panhead rocker arm assemblies must be used. **Sold in sets.**

17-118 Pan/Shovel Cylinder head set

Note: Because steel head bolt inserts are not used in these parts, it will be necessary to source a set of 7/16"-14 head bolts to facilitate installation.

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